REPORT NO. 90-R-04
AFPEA PROJECT NO. 90-P-123

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CONTAINER VARIATION TESTING FOR THE PREVENTION OF CORROSION

HQ AFLC/DSTZ
AIR FORCE PACKAGING EVALUATION ACTIVITY
Wright-Patterson AFB OH 45433-5999

September 1990

NOTICE

ABSTRACT

Aerospace Maintenance and Regeneration Center (AMARC), Davis Monthan AFB AZ, requested assistance from the Air Force Packaging Evaluation Activity (AFPEA) in establishing proper packaging procedure for the B-1B Pylon.

The wood crates used to ship and store the B-1B pylons were designed from combined requirements of MIL-STD-26195 and MIL-C-104 and were designed for level C packaging requirements, which indicate immediate use, within three to six months. However, due to the Strategic Arms Limitation Treaty, the pylons were stored in the containers for an extended period of time. As a result of this extended storage, corrosion of the cadmium-plated connector plugs occurred. This corrosion is believed to be the result of formic acid attacking the cadmium-plated parts. The formic acid formation is due to the outgassing of formaldehyde from the wood, combining with water and oxygen.

The decision was made to paint the interior and exterior of the container and to add ventilation in lieu of placing the B-1B pylon inside a barrier bag. A barrier bag was not recommended due to the expense, resealing difficulties, and periodic inspection requirements.

Tests to identify the best possible combination of container characteristics were recommended by AFPEA so that future programs would not have to involve an educated guess. The results of testing, the test plan devised in accordance with MIL-STD-810D, show that in all cases venting the container led to a higher rate of corrosion than not venting. Additionally, painting the interior of the container did lead to a much lower rate of corrosion.

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INTRODUCTION

BACKGROUND: Aerospace Maintenance and Regeneration Center (AMARC), Davis Monthan AFB AZ requested assistance from the Air Force Packaging Evaluation Activity (AFPEA) in establishing proper packaging procedures for the B-1B Pylon.

PURPOSE: The purpose of this testing was to determine which if any of the variations in treatment and venting of the containers would correct the existing problem of corrosion on the cadmium-plated parts, which was apparent during extended storage.

DESCRIPTION OF THE TEST CONTAINERS

DESIGN and CONSTRUCTION: Six 2' x 2' scale models of the cleated plywood containers designed from combined requirements of MIL-STD-26195 and MIL-C-104 were used for testing (see figure 1). Each container weighed 70 pounds. Each container's cover was detachable at the skid, however, the spray painting sealed the cover to the base so the top plate of the container was used for entry and resealed with drywall screws (see figure 2).

TREATMENT and VENTING: Six variations of treatment and venting are outlined below, one container per variation.

TREATMENT	NOW REFERRED TO AS:
NO COATING, VENTED	CONTAINER 6
NO COATING, NOT VENTED	CONTAINER 3
COATED (EXTERIOR ONLY), VENTED	CONTAINER 1
COATED (EXTERIOR ONLY), NOT VENTED	CONTAINER 2
COATED (INTERIOR and EXTERIOR), VENTED	CONTAINER 4
COATED (INTERIOR and EXTERIOR), NOT VENTED	CONTAINER 5

The coating was four to six millimeters of Southwest Paint and Varnish Companies' Kool Coat, a white paint, that is not gas permeable and is resistant to ozone deterioration.

TEST OUTLINE AND TEST EQUIPMENT

TEST PLAN: The test was done in accordance with AFPEA test plan 90-P-123 (see table 1). The test was selected to produce the most favorable conditions of humidity and temperature to enhance corrosion. The test method used was a modified procedure outlined in MIL-STD-810D. The pass/fail criteria was the visual inspection for the presence of corrosion.

TEST LOAD: Two cadmium-plated connector plugs with the cables attached, were placed inside each of the six containers, suspended so that the connector plugs were not in contact with any surface (see figure 3). The plugs were not treated with any preservative. The history and age of these connector plugs are not obtainable and actual B-1B connector plugs were not available due to cost factors.

TEST SITE: All testing was conducted at AFPEA, HQ AFLC/DSTZ. Equipment required for testing is noted in the test plan.

TEST PROCEDURES AND RESULTS

HIGH TEMPERATURE, HIGH HUMIDITY CYCLING TEST: Testing was conducted in accordance with MIL-STD-810D, Method 507.2-7. The cycles were modified to create a more aggravated condition so that test duration was shorter.

RESULTS: At the end of one week of testing, the containers were opened and a visual inspection made of the connector plugs. The inspection revealed definite signs of corrosion on the plugs in containers 3 and 6. Very slight signs of corrosion on the plugs in containers 1,2 and 4 and the plugs in container 5 showed no signs of corrosion. The containers were then resealed and the test resumed. The entire inspection procedure lasted approximately one hour.

At the end of two weeks of testing, the containers were again opened and visual inspection revealed increased corrosion on all plugs. The plugs in containers 3 and 6 had the most corrosion. Plugs in containers 1,2 and 4 showed slightly increased levels of corrosion. The plugs in container 5 showed signs of corrosion just starting. The containers were resealed and the test resumed.

At the end of five weeks the containers were opened and a visual inspection revealed that the levels of corrosion on all plugs had increased. The plugs in container 5 showed the least amount of corrosion. These results are pictured in figures 4,5 and 6. The test was concluded at this time.

CONCLUSION

The container which was coated inside and out (with white paint) and not vented provided the best protection for the cadmium-plated parts against corrosion

RECOMMENDATIONS

The results obtained in this test lead to the conclusion that the proposed resolution may not create the best condition to prevent corrosion on the cadmium-plated parts. It is recommended that future storage containers be painted inside and out but not vented.

Since the history and age of the connector plugs used in this test was not obtainable, it is recommended that the test be repeated with new cadmium-plated parts or test samples/specimens to see if the same results are obtained. It is also recommended that one test sample/specemen in each container be coated with the preservative presently being used on the B1-B pylon. An untreated bare piece of steel (1010 or 1020) and aluminum (6005-T5) should also be placed in the containers, as samples of typical materials shipped and stored, for comparison.

TABLE 1

AIR FORCE PACKAGING EVALUATION ACTIVITY

(Container Test Plan)

AFPEA PROJECT NUMBER: 90-P-123

CONTAINER SIZE (L x W x D)(INCHES) INTERIOR:	EXTERIOR:	WEIGHT (LBS) GROSS:	ITEM:	CUBE (CU. FT.)	QUANTITY	DATE
	28 x 26 x 26	70	3	10.9		27 AUG 90

ITEM NAME: Cadmium-plated connector plugs

MANUFACTURER:

CONTAINER NAME: 2' x 2' CLEATED PLYWOOD BOX

CONTAINER COST:

PACK DESCRIPTION:

CONDITIONING: As noted below

TEST NO.	REF DTD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRU-MENTATION
1.	HIGH TEMPERATURE, HIGH HUMIDITY CYCLING TEST			
	MIL-STD-810D Method 507.2-7 (modified)	30 day test period. One cycle per day. Constant wet bulb temperature of 117°F. Dry bulb temperature varied as follows: Start at 118°F remain at 118°F for 8 hours. Change dry bulb to 140°F remain at 140°F for 8 hours. Change dry bulb temp to 118°F remain at 118°F for 8 hrs. Repeat last three steps every 24 hours. This causes the humidity to vary from 97% to 51% to 97% respectivly.		Instrumentation to verify temperature and humidity readings.

COMMENTS:

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Ted Hinds Chief, Design Br.

FIGURE 1

CONTAINERS.

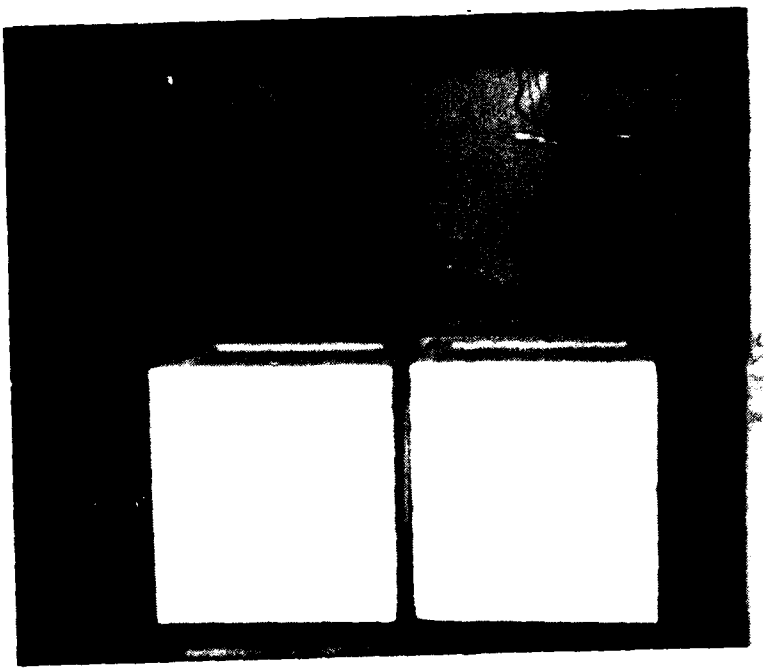


FIGURE 2

RESEALING WITH DRYWALL SCREWS.

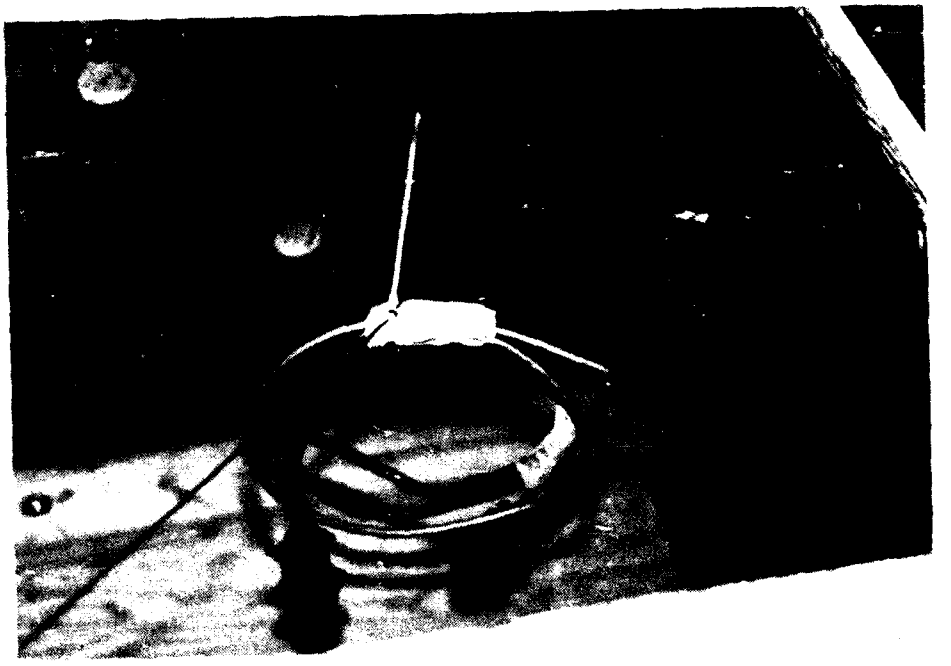


FIGURE 3

PLACEMENT OF TEST LOAD.

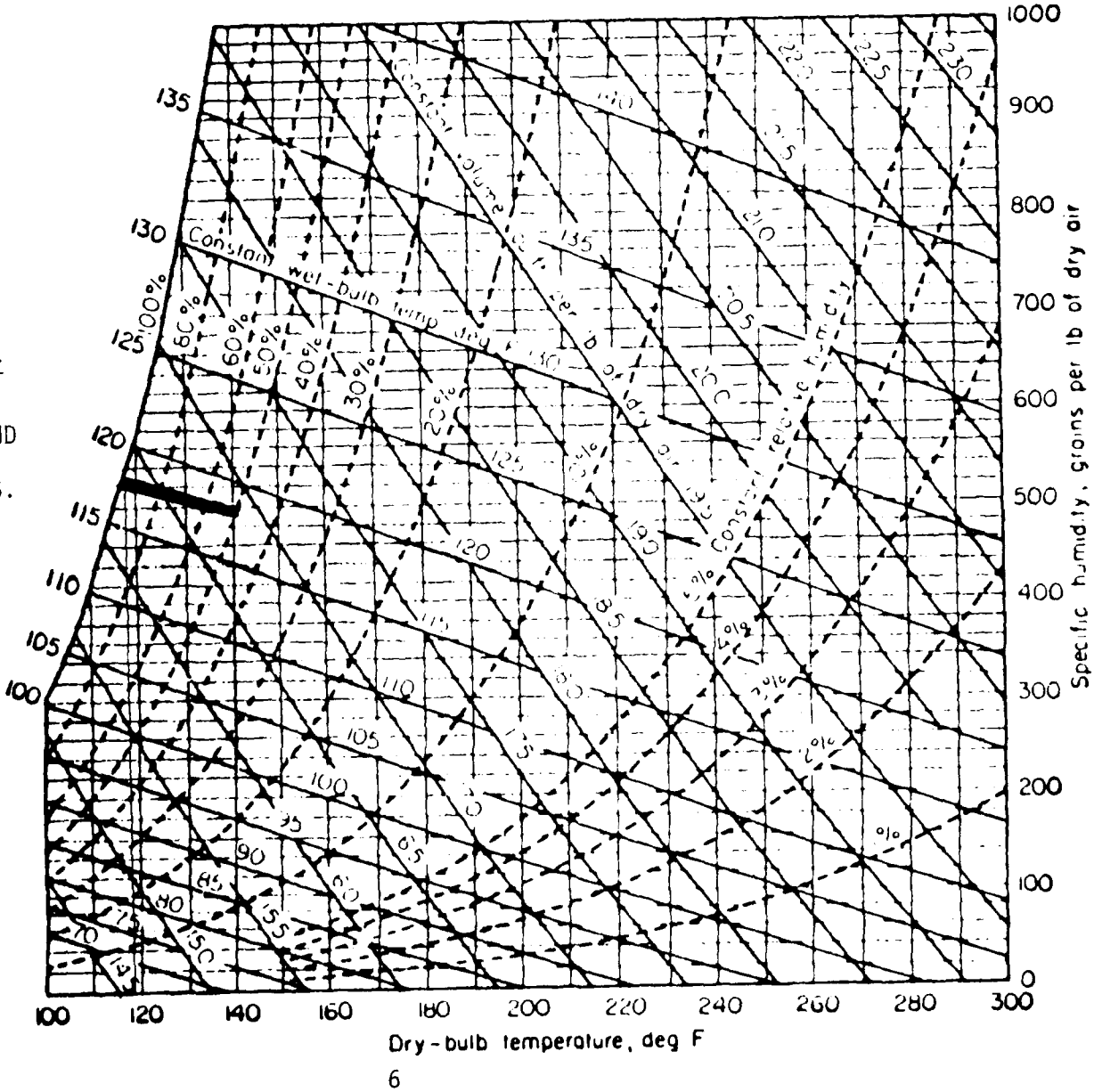


FIGURE 4

HUMIDITY CHART AND BULB SETTINGS.

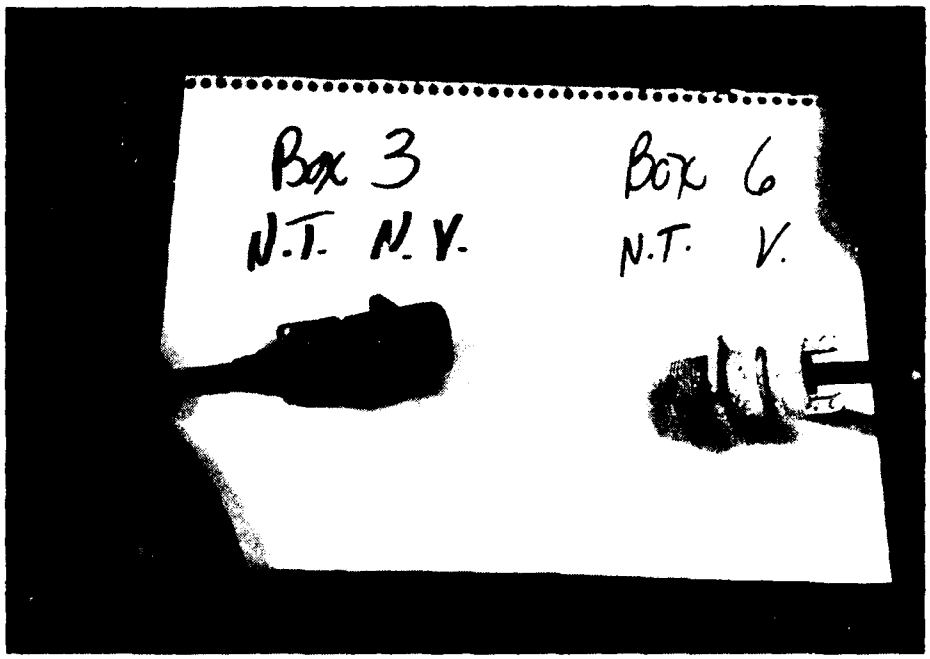


FIGURE 5

TEST RESULTS FOR CONTAINERS 3 AND 6.

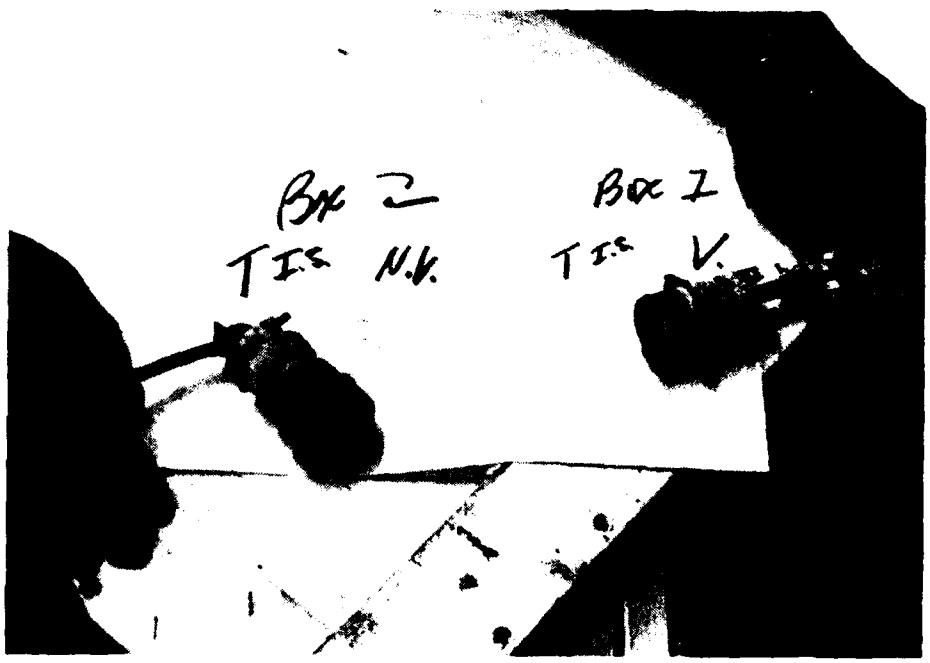
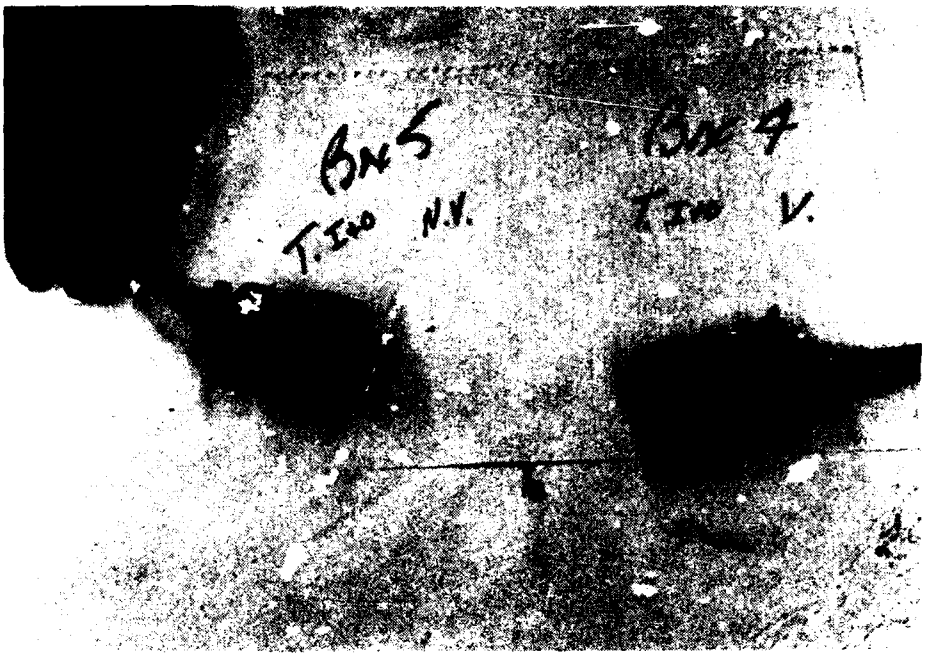


FIGURE 6

TEST RESULTS FOR CONTAINERS 1 AND 2.

FIGURE 7

TEST RESULTS
FOR CONTAINERS
4 AND 5.



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